Standing wave fluorescence spectroscopy of superconductors

K.C. Prince[1] and M. Matteucci[2]
[1]Sincrotrone Trieste, Strada Statale 14, km 163.5, Basovizza (Trieste), Italy,
Kevin.Prince@Elettra.Trieste.It, fax +39-040-3758565,
[2]CNR, presso Elettra, Strada Statale 14, km 163.5, Basovizza (Trieste), Italy

INTRODUCTION

In the normal incidence standing wave technique, x-rays are impinge on a sample normal to a set of lattice planes and selectively photoexcite core holes in substrate or adsorbate atoms. A signal proportional to the strength of photoabsorption (such as photocurrent or Auger yield) is measured as the wavelength is scanned through the rocking curve. From the data acquired the structure is determined, and this method is now an established technique.

In the prsent proposal we have attempted two variations on this theme. Firstly we aimed to reduce the energy at which the spectrum is measured from the typical value of several keV to around 1 keV. This is a more difficult region from the point of view of obtaining sufficient resolution but it is well adapted to (002) reflections from perovskite type superconductors for example. Secondly, instead of trying to extract structural information, we know the structure from x-ray crystallography and we wish to extract the fluorescence spectrum of chemically distinct atoms.

MEASUREMENTS

The samples measured were doped GdBa2Cu3O6.5 thin films grown epitaxially on single crystal substrates, and BISCO (Bi2Sr2CaCu2O8) superconductors. The calculated energies for (002) reflections were 1058 ev and 403 eV respectively. The idea was to set up the standing wave conditions using one of the minority elements in the crystal structure (Ba or Ca) as these are senistive to the standing wave position, and then tune the incident radiation to excite on or other non-equivalent atoms in the structure (such as the Cu.)

In the case of BISCO, the fluorescence yield of Ca Lα emission was not sufficient at 400 eV to tune. This is presumably because the concentration of Ca is low (one atom out of fifteen in the unit cell) and the absorption is too weak. This sample was therefore abandoned.

For GdBa2Cu3O6.5, the Ba fluorescence yield from M V holes was measured in the energy region where the standing wave was expected. The calculated energy width of the the standing waves region was 0.7 eV, and the monochromator was set to a value a little higher than this. However no clear signal was found. Just above the range the Ba 3p3/2 level is excited and causes flourescence emission by cascade processes, fig. 1. Attempts were also made to locate the standing wave condition using other signals, such as the sample drain current, but these were unsuccessful.

The proposal received 7 shifts (31.10-2.11) but during this period the machine suffered severe problems with longitudinal feedback, so that only about half of the allocated time was usable (sudden beam losses, no beam for one period of 13 hours, instability, unscheduled change from 1.5 to 1.9 GeV.) Time did not allow a variation of the emission angle or tests of total fluorescence with the channel electron multiplier.

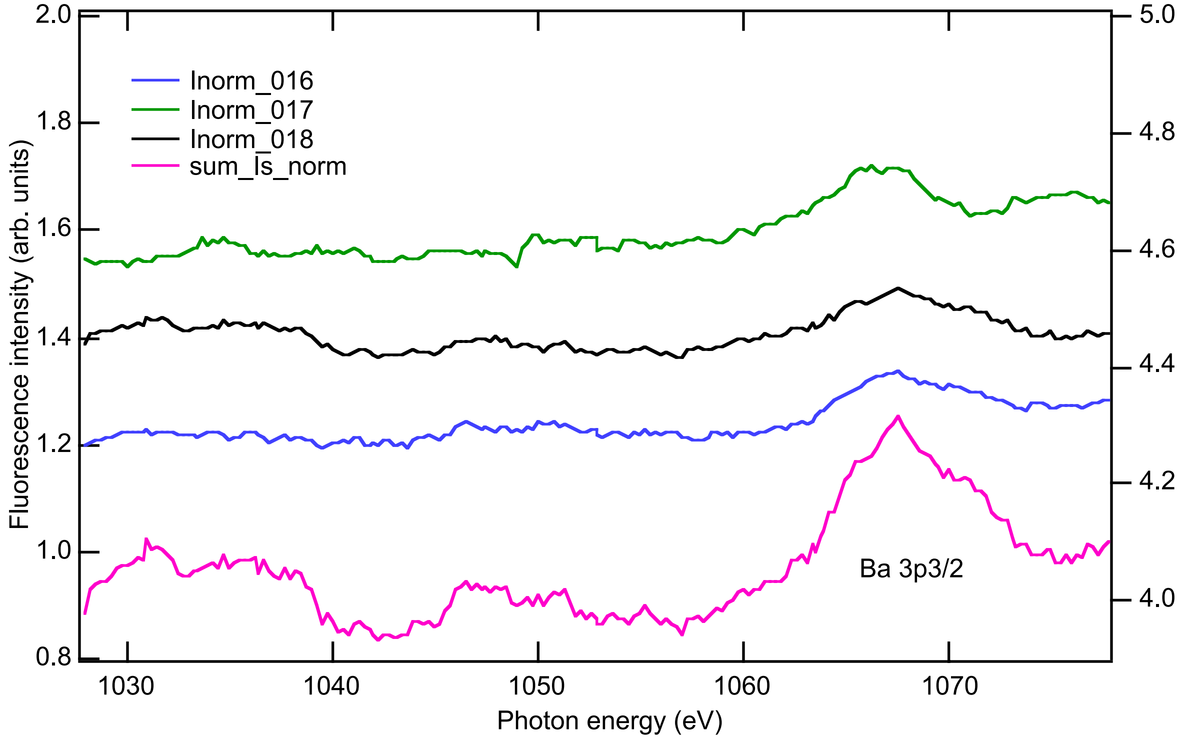

Fig. 1. Normalised scans in the energy range where normal incidence standing waves are expected to occur.

CONCLUSIONS

Preliminary and very brief tests have been made to seek a NISW effect in fluorescence yield. The effect has not yet been observed and further tests are needed with variations of other experimental parmeters.

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[1] D.P. Woodruff et al PRL **58** (1987) 1460.

Principal investigator: Kevin Prince, Sincrotrone Trieste. Telephone: +39-040-3758584. Email: Kevin.Prince@Elettra.Trieste.It.